TPC Design/Construction for the Field Response Calibration

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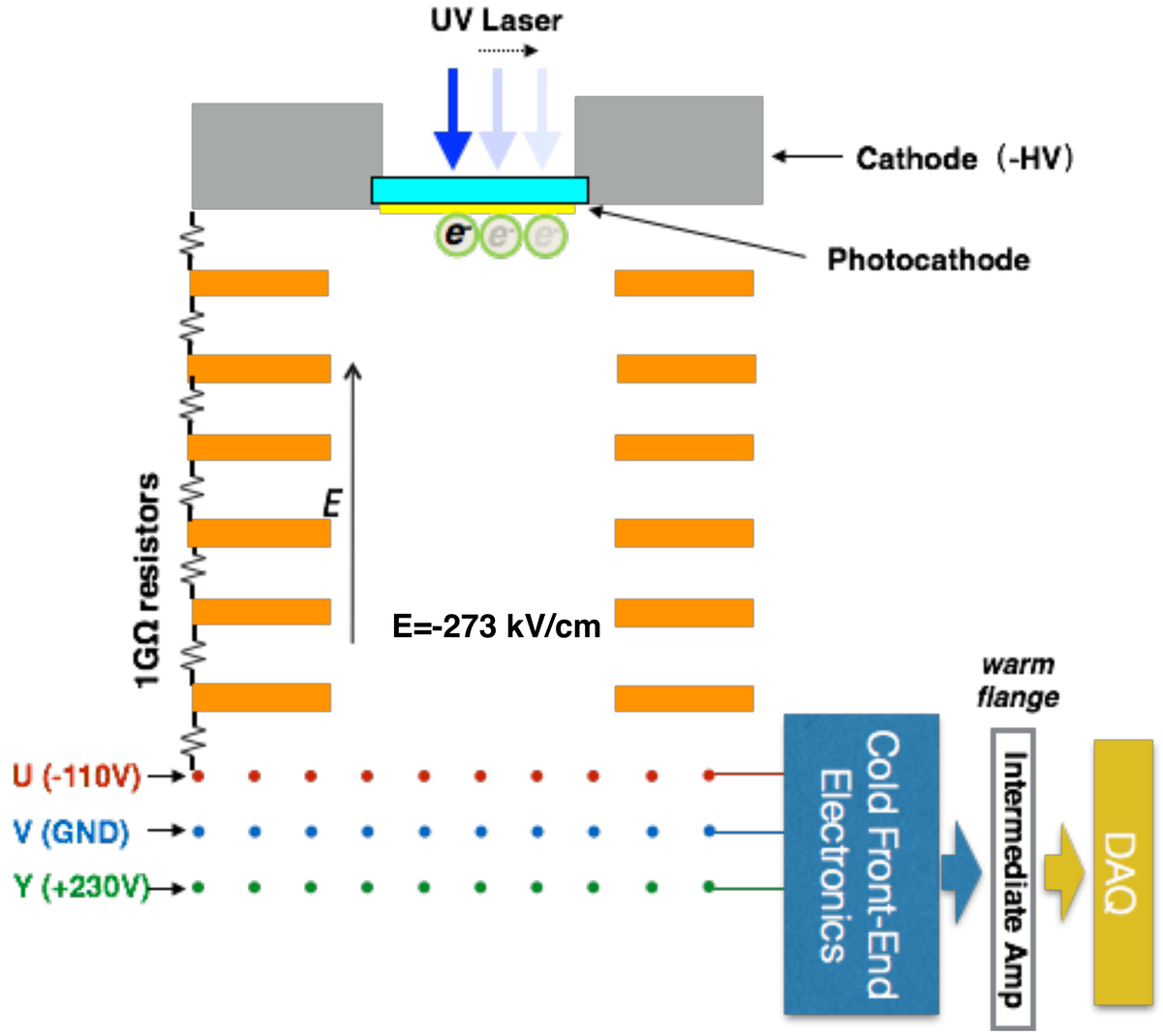
Outline

- Measurement scheme
- TPC construction
- Laser system
- Summary

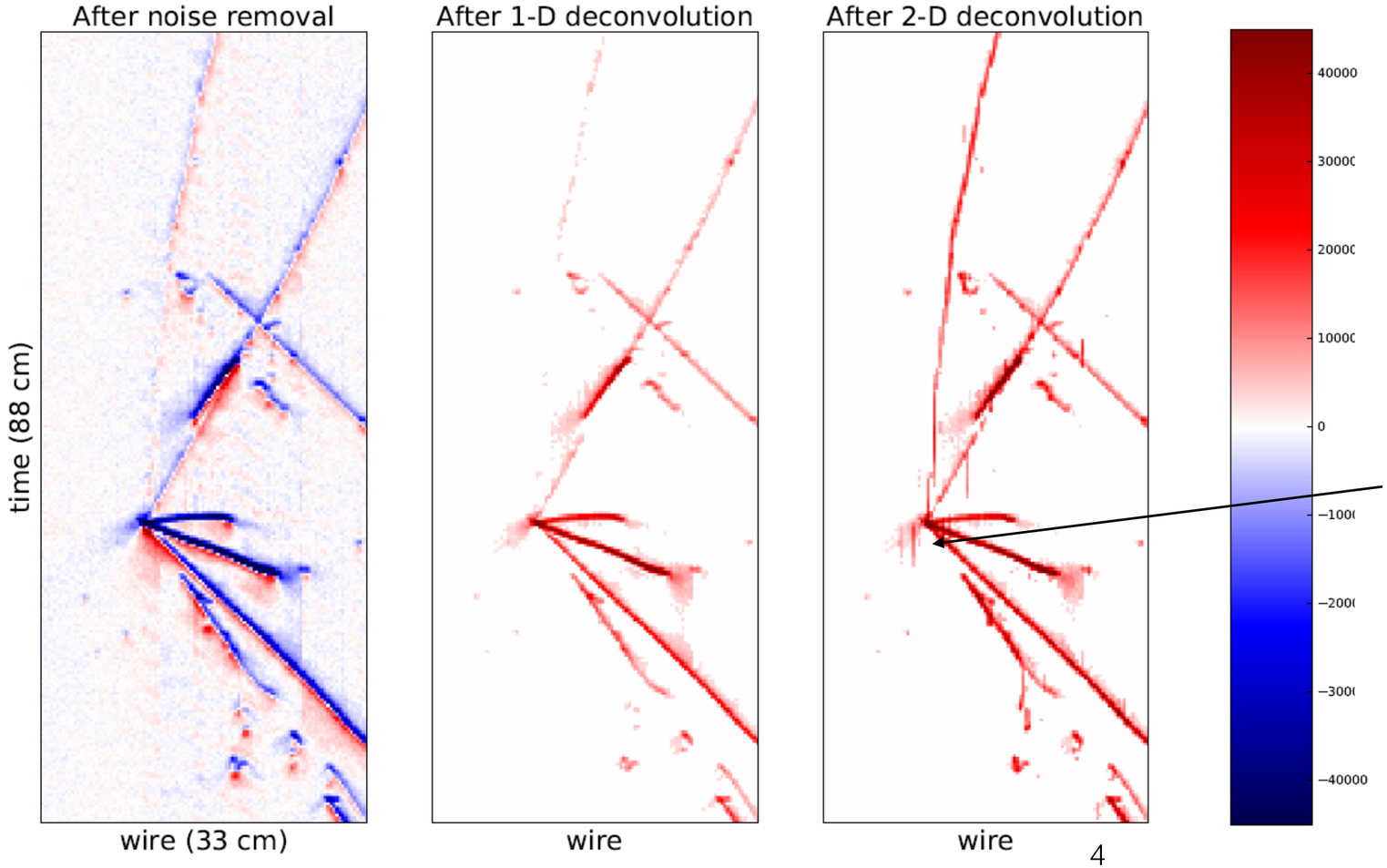
Measurement Scheme

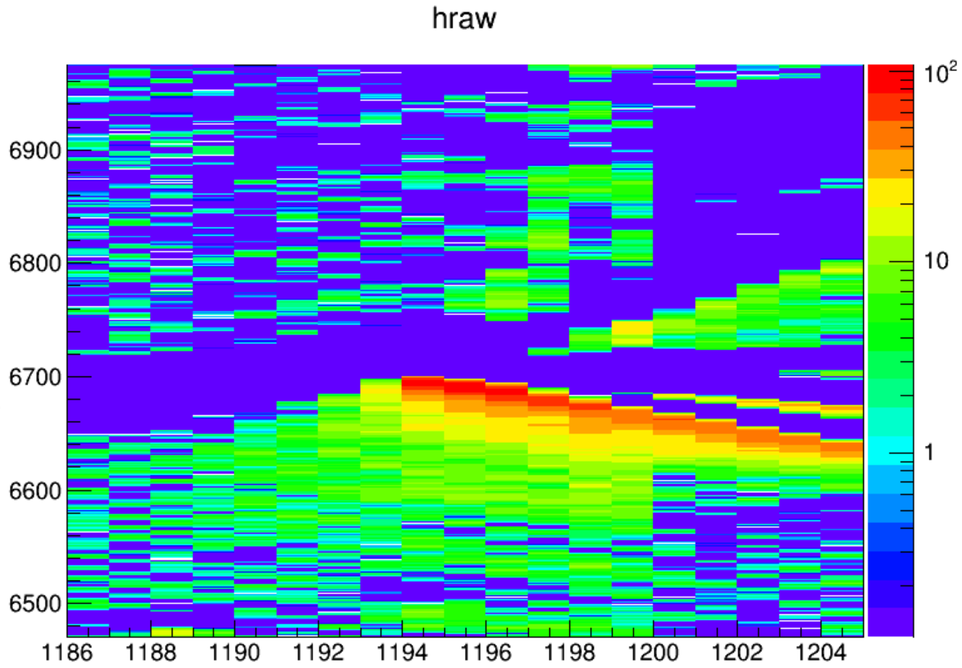
1. The very first application of the field response measurement is for MicroBooNE
2. A TPC is required to reproduce the field conditions of MicroBooNE
3. Point electron source at varied locations are preferred
4. The wire plane configuration would be the same as MicroBooNE



TPC data from MicroBooNE

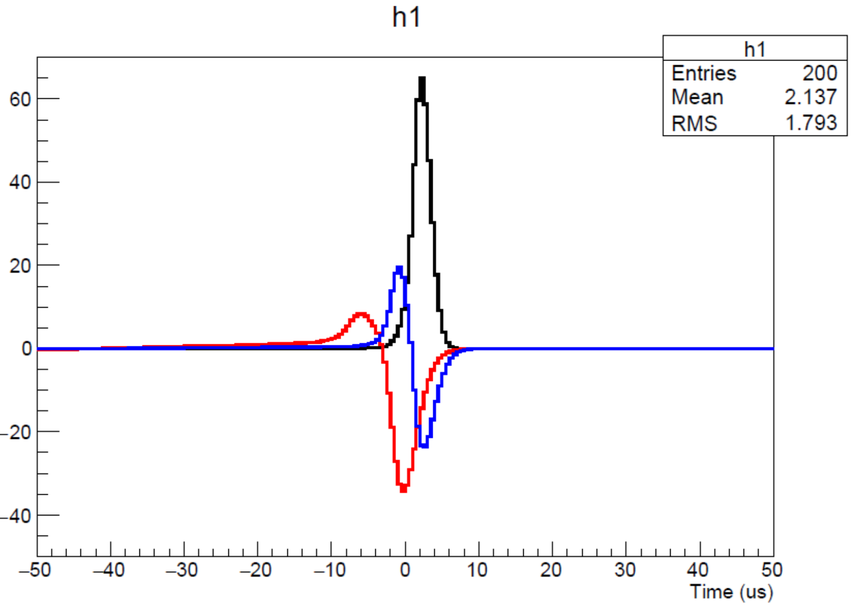
1. This an event from MicroBooNE data on U plane
2. The shadow near the vertex indicates obvious effect of the induction on the neighboring wires
3. The induction range determines our number of wires



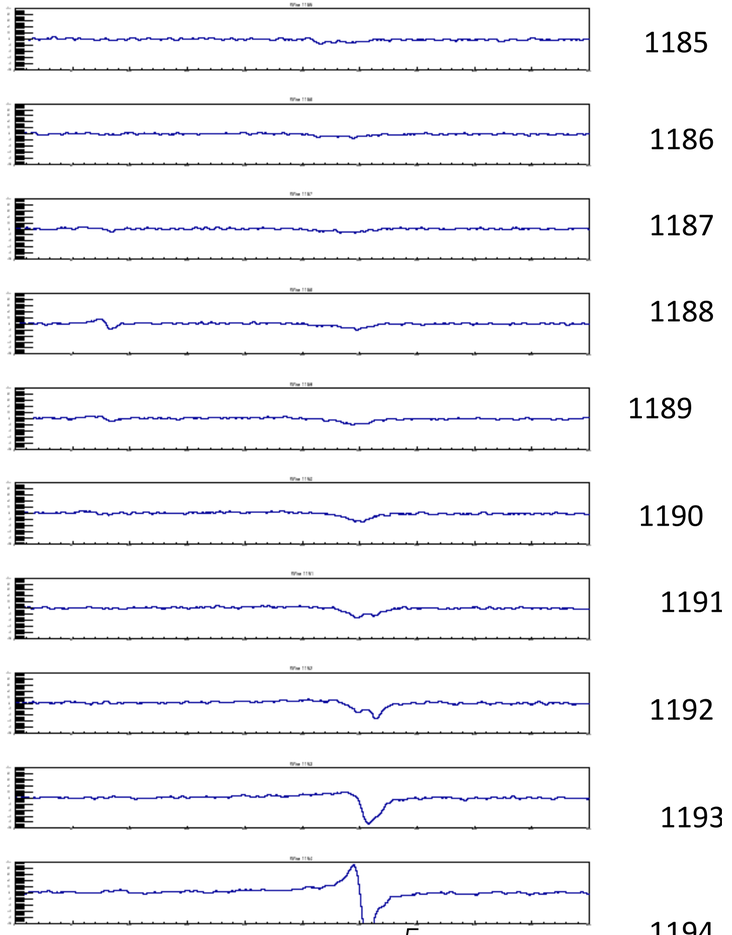


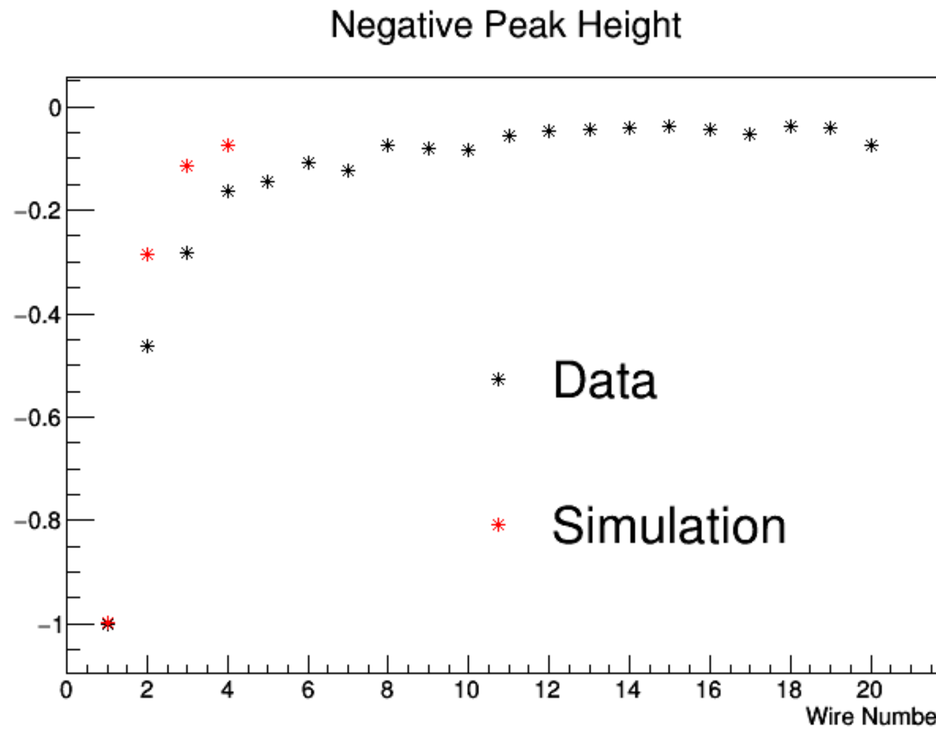
TPC readout range condsideration

1. Look at the wires, it is clear the amplitude of the negative pulse reduce on further wires
2. The effect is more significant than what we saw in the 2D simulation
3. We need to measure at least 10 wires away from the center



simulated shape





TPC Dimensions Considerations

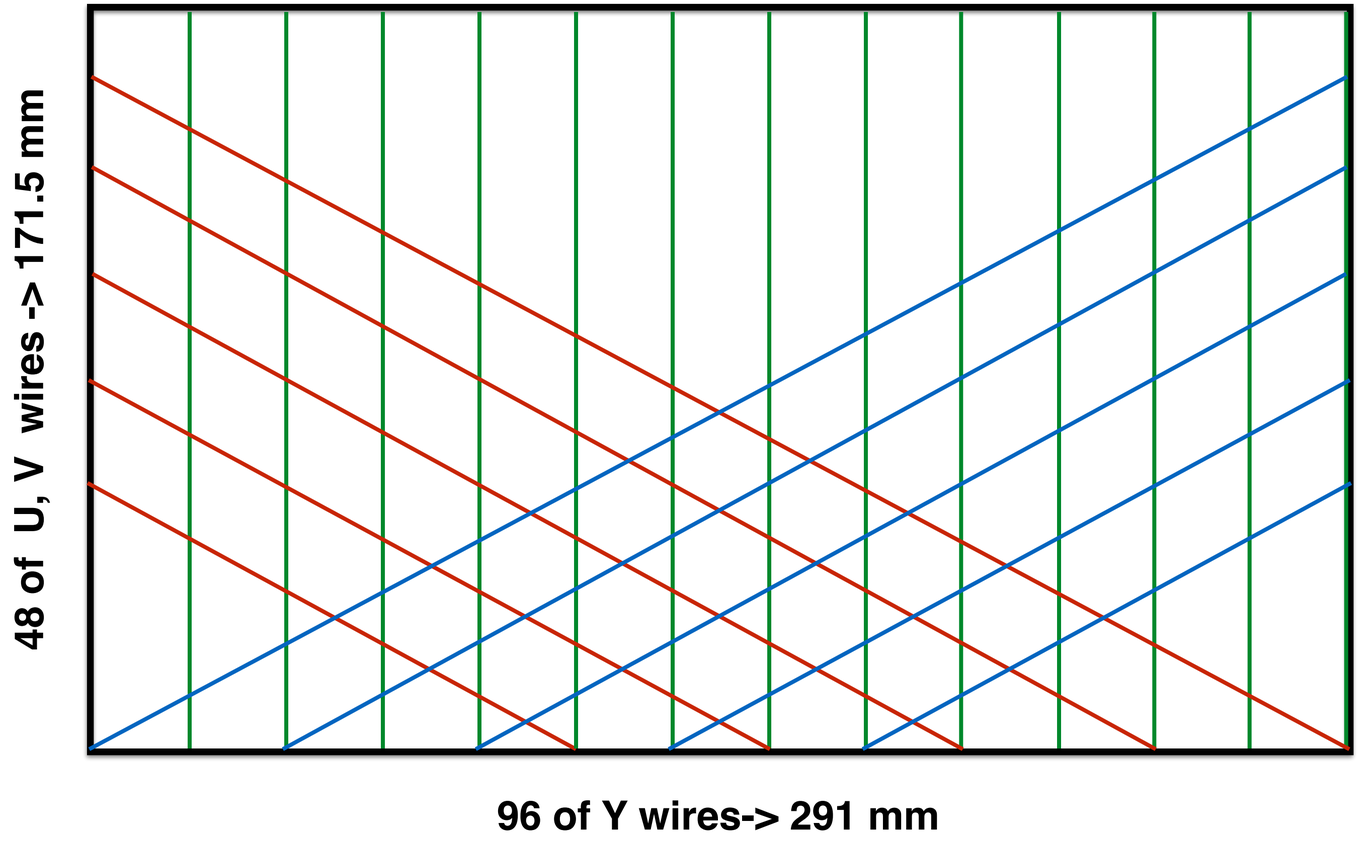
1. The key components of the TPC dimensions are:
   a. Wire pitch (3mm)
   b. Wire plane number (3 planes: U, Y, W)
   c. Wire angle (60 degree)
   d. Drift distance (~10 cm)

2. With rectangle shape TPC. The overall dimensions are
   29.1 cm x 17.2 cm x 11 cm

3. Wire configuration:
   U: 48 x V: 48 x Y: 96

4. A single MicroBooNE Front-End mother board contains 192 channels.

5. See Jyoti's talk



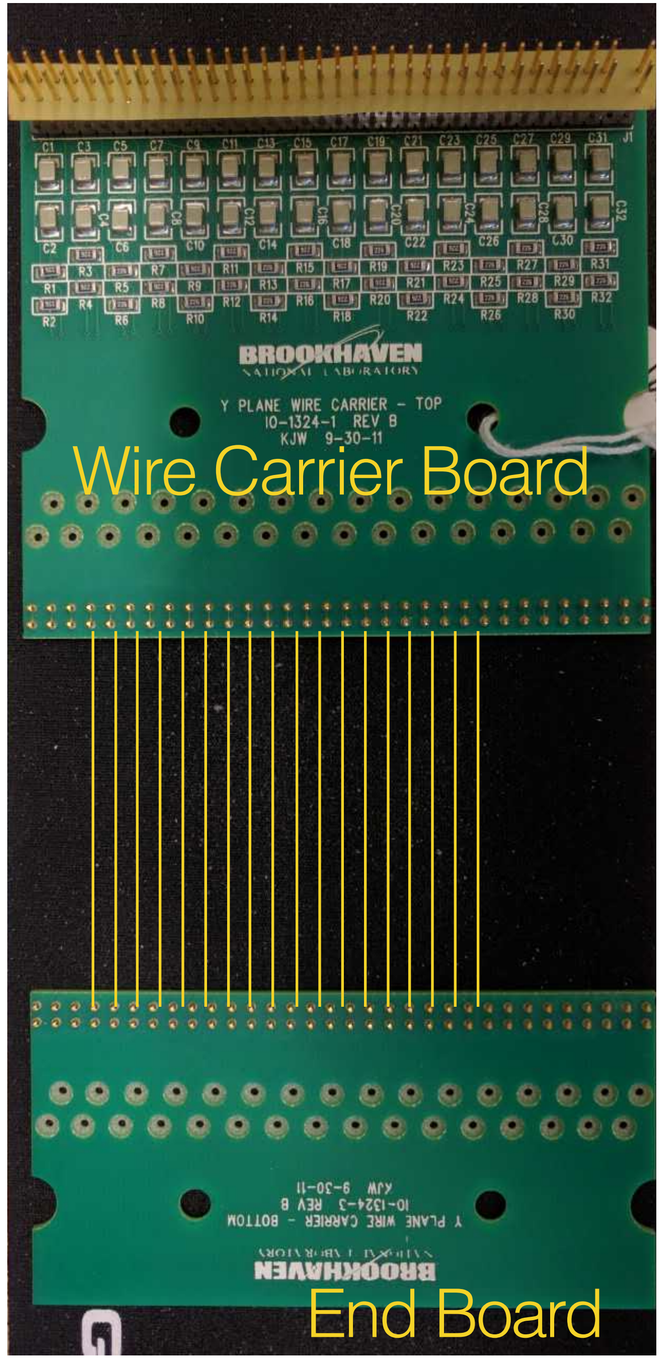
TPC Construction

1. We are going to duplicate the MicroBooNE wiring scheme with some simplifications :
   Wire—>Wire Carrier Board—>Front-End Motherboard

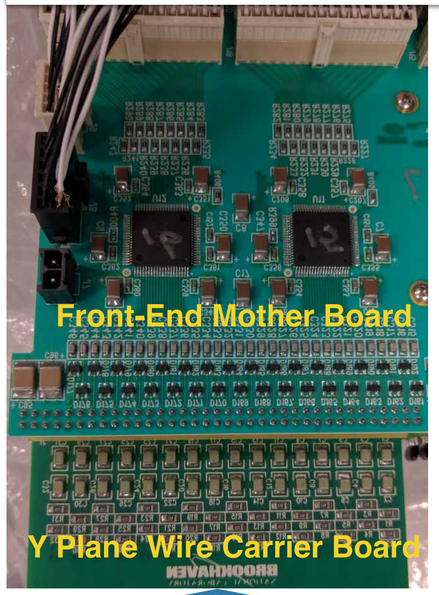
2. There should be no major technical difficulties on the construction

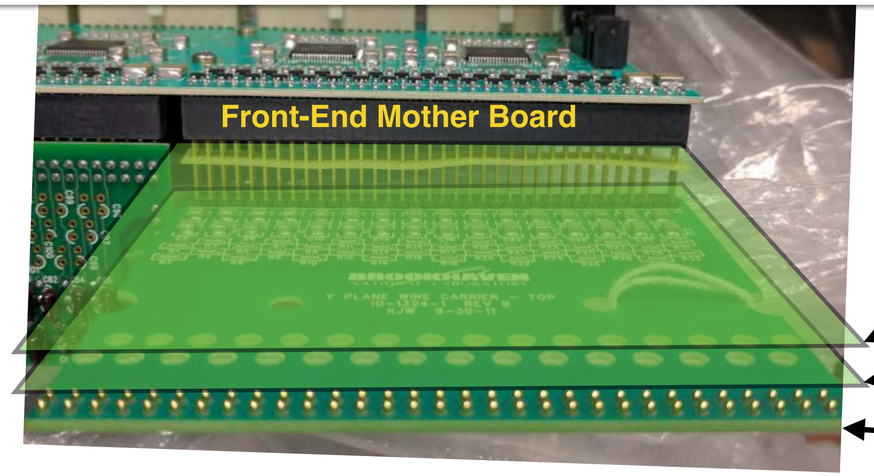
3. We would need to produce new wire carrier board with some modifications to the existing MicroBooNE wire carrier board

4. Front-End electronics at the bottom of the TPC is viable



MicroBooNE Wiring Scheme

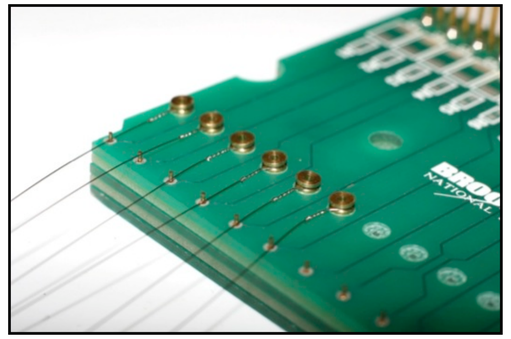




U Plane Wire Carrier Board

V Plane Wire Carrier Board

Y Plane Wire Carrier Board

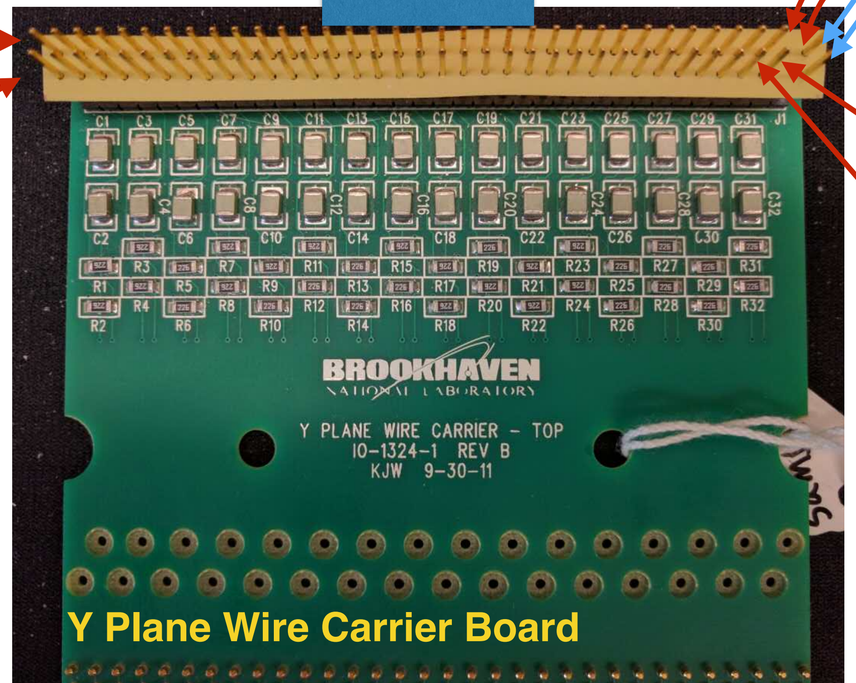


Wire bias

Y: 32 ch

U: 16 ch

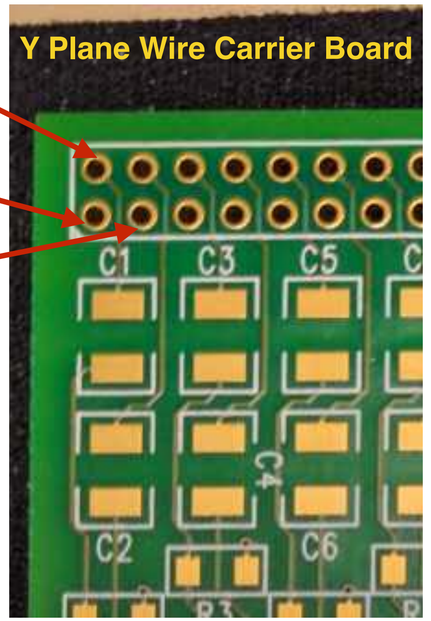
V: 16 ch

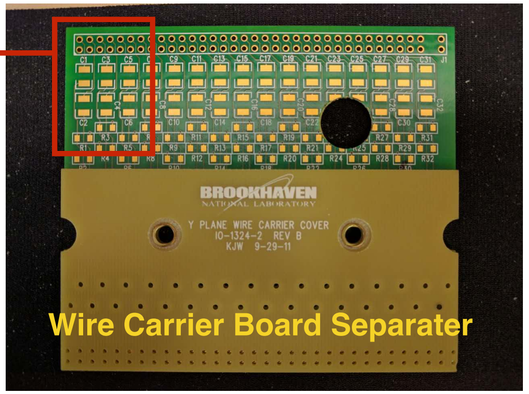


Y

U

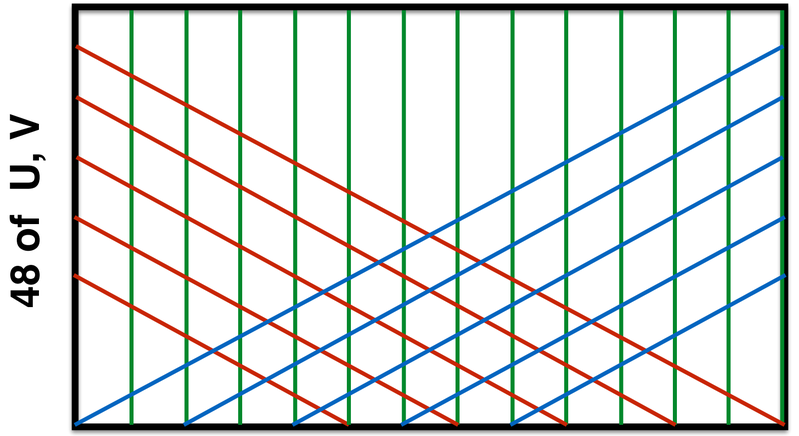
V

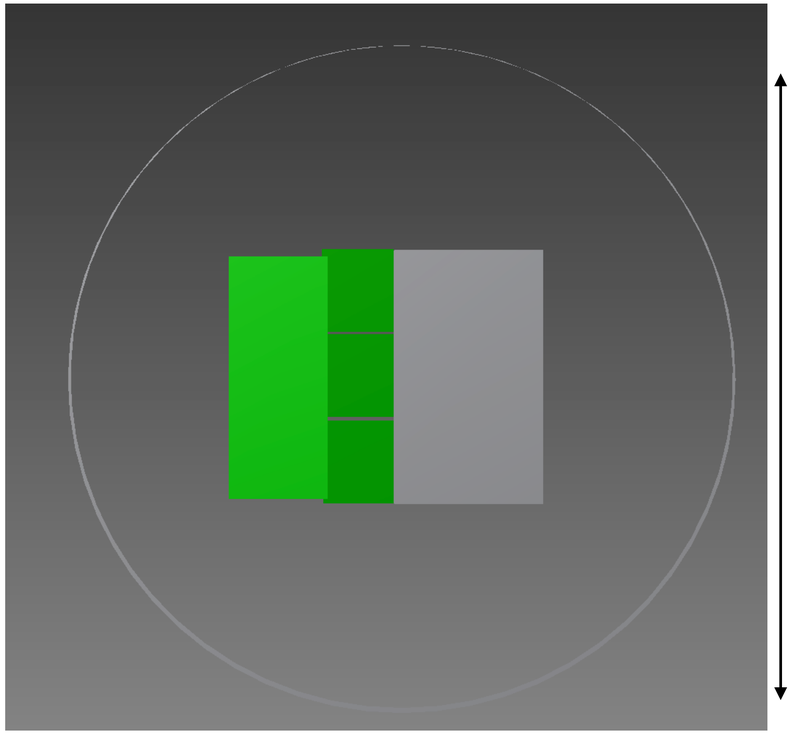




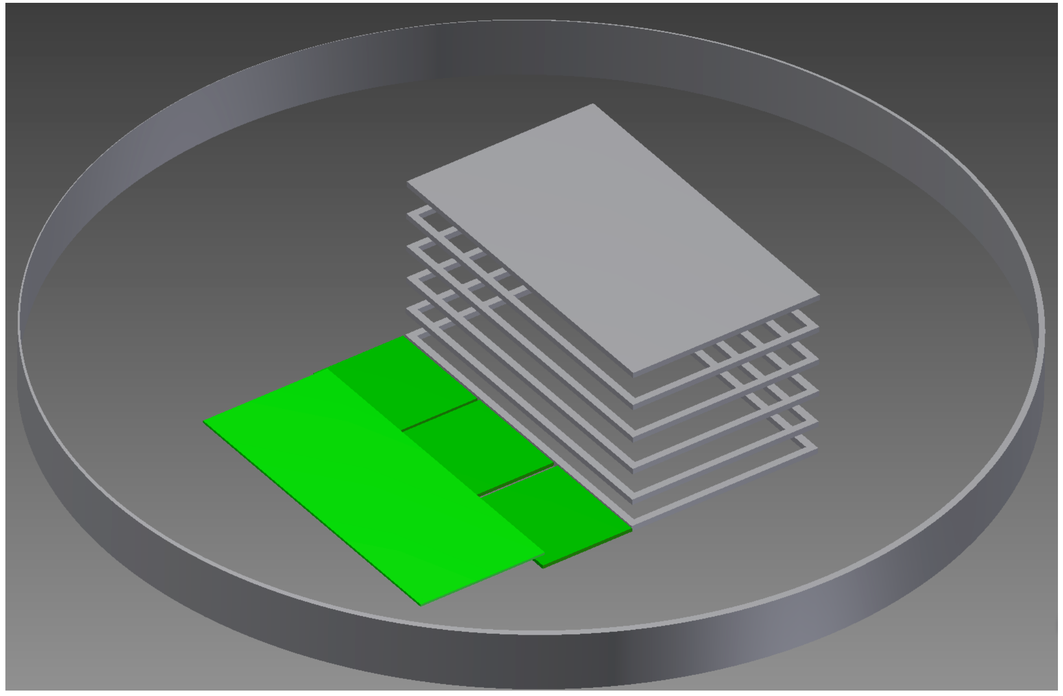
TPC Construction for LArFCS

1. With the dimensions we have, we can do some simple assembly test in the model
2. The TPC can probably be slightly bigger than the current dimensions
3. Other shape can also be considered
4. The 20L system is not large enough



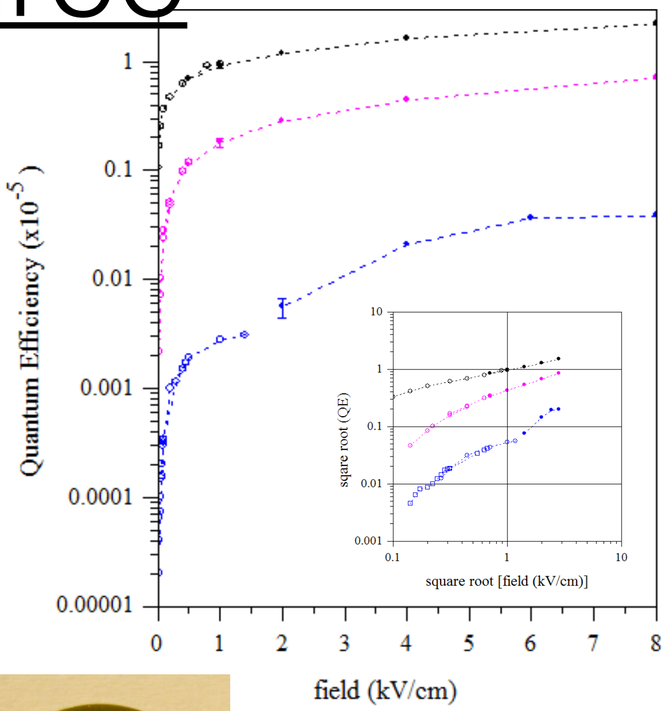


30”



Laser: Electron Source

1. Noise level is expected to be <400e ENC
2. 13.7 k electrons (MIP with 3mm in LAr)->35 ADC at 14mV/fC gain, at maximum at 25 mV/fC gain, it is ~63 ADC
3. Take 5% reduction of induction signal far away, we have 3 ADC…If we want to achieve 10 ADC, at 12-bit ADC, taking into consideration of recombination, we would need 50 k electron production at cathode.
4. The photocathode has a damage threshold of 6mJ/cm^2, in 20L system has achieved150um spot size with 2.7uJ laser power
5. The QE of gold photocathode reduces a 273 V/cm ~ 4E-9
6. In order to get 50k electrons, we need one order of magnitude higher laser power, and the spot size enlarge to 400-600um
7. We can get a spare excimer laser from Instru. Div. with adequate power (~50mJ).
8. The photocathode will be evaporated on sapphire which has been used.



Resources Summary

Existing Resource

1. MicroBooNE FE motherboard design
2. MicroBooNE feedthrough flange from Fermilab
3. HV suppliers
4. Excimer laser
5. Bo's expertise on TPC :)

Additional Resources needed:

1. Designer to produce drawings
2. Materials for TPC construction
3. New wire carrier board
4. Optical parts: lens, mirror, photodiode etc.
5. Optical feedthrough on the flange
6. Cost: 15 K

Summary

- A small TPC with scales of 29 cm x 17 cm x 11cm will be built for the measurement
- We are going to use the modified MicroBooNE wire carrier board and same wire configuration
- A powerful laser has been located to produce enough number of electrons